TEXTILE RESEARCH

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VOL. XIII **TEXTILE RESEARCH** NO. 4

Outstanding Features in

This Month's Issue

Technological Mobilization

The main features of the Senate Bill to mobilize technical manpower and facilities are described. (See page 2.)

Modern Textile Technology

In "Merging Molecules," Edward R. Schwarz describes progress in the study of fiber structure and discusses the significance of the union of chemistry and physics to a better engineering of textiles. (See page 4.)

Strength of Cotton Fiber Bundles

Figures cited show how rapidly cotton fiber bundle strength is lost with the departure from a straightened condition when twist is inserted. (See page 18.)

Combination of Wool With Weak Acids

Practically all of the studies which have been made on the chemistry of the reaction of wool with acids have been made with *strong* acids. The present paper fills in part this gap in our knowledge. (See page 24.)

Abstracts

Technical and scientific articles are abstracted in this, the second issue in which appears this new department. (See page 33.)

Maximum Efficiency in Use of Technical Facilities Is Sought Through Proposed Office of

Technological Mobilization

To MAKE FOREVER SECURE America's world leadership in the practical application of scientific discoveries, and to mobilize for maximum war effort the full powers of our technically trained manhood and all technical facilities, equipment, processes, inventions, and knowledge, are the stated purposes of Senate Bill S. 2721.

The bill, as presented, sets up a corporate body under the name of Technological Mobilization Corporation with a capital stock of $200,000,000 subscribed to by the United States through the Secretary of the Treasury, payment for which to be on call by the board of directors.

Very broad powers are given to the Corporation such as giving it full access to all governmental and private information on the current use being made of scientific and technical personnel and facilities, and to draft all such personnel and facilities failing to submit or to accept plans for immediate conversion of their efforts to work deemed more essential.

"It is directed to review all projects for research and development; it shall promote such projects as it deems appropriate that are consistent with the purposes of the act; and shall initiate through a staff of its own such additional projects as it can."

It would be also empowered to make loans, grants, or advances to private persons or organizations to enable the construction and development of research laboratories, semiworks plants and pilot plants, or the conversion or expansion of such.

The first hearings on the bill brought out interest-

ing testimony from a number of prominent men among whom were Henry M. Kaiser; Donald Nelson; Hiram W. Sheridan, airplane pilot and inventor; C. P. Bedford, general manager Shipyards Permanente Nos. 1 and 2, and Kaiser Nos. 3 and 4; and Waldemer Kaempffert, science editor, New York Times. It was brought out at the hearing that there does exist now a multiplicity of governmental research and technical activities with overlapping and duplication of functions. However, there was general agreement that there would be a great advantage in the introduction by the government of an office such as is proposed, or some modification of the plan.

It was felt that this office would go far toward eliminating the bottlenecks of technological inadequacies and scientific defects—so many patents frozen and new inventions blocked, so little attempt to develop the initiative of inventors that exist at present.

Testimony at the hearing tended to show that in Germany, even prior to Munich, there was practically 100 per cent mobilization of all technical personnel in the Reich. On the contrary, it showed that in France quite the reverse was true; that instead of mobilization of technical personnel they had mobilization of the army, and demobilization of the technical personnel drawn from the technical pursuits in which they were normally engaged and in which they would be of value to the state, and also to the army, thereby breaking down to a great degree the efficiency of production of the French Republic.

Mr. Kaiser gave considerable detail in regard to his methods of pooling ideas and increasing production; and strongly advocated greater interchange of technique and information between industries.

The complete bill and testimony at the hearings with many exhibits describing governmental and other technical organizations, are contained in Volume 1, (291 pp.) issued by the U. S. Printing Office, Washington and the title: Hearings Before a Subcommittee of the Committee on Military Affairs United States Senate on S. 2721.

E. R. Schwarz Describes Significance Of Fiber Structure in

Modern Textile Technology

II. Merging Molecules

By E. R. SCHWARZ, F.T.I.*

This is the second article in a series by Dr. Schwarz. The first article appeared in Textile Research, *Dec. 1942. Other articles will discuss in detail some of the general aspects raised in the first two articles of the series. The application of polarized light, electron microscope, creep and creep recovery, will be among the subjects considered (Editor).*

Textile materials are useful to man primarily because of their combined properties of lightness, flexibility and strength. They are therefore particularly well adapted for clothing because their weight is so low as to make for convenience and comfort in carrying them on the body in quantity sufficient for protection and warmth. Compared with other materials of sufficient strength, such as many of the metals, they have a much lower weight per unit volume. Cotton is stronger than lead and has only one-eighth the density. For the same cross section it is as strong as iron and only one-fifth as heavy. A woolen overcoat is lighter, warmer and much more comfortable than a coat of mail. A thick felt jerkin (Fig. 1) was effective, both as a satisfactory garment and as armor for the protection of Roman and Persian soldiers against

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arrow, sword and spear. The present fabric military pack with its entire contents is lighter than the metal armor once worn by fighting men. But the cry is even now for lighter equipment and the utmost skill of the textile technologist is being utilized to still further achieve greater lightness plus greater durability.

Fig. 1. Courtesy Western Felt Works

For mechanical usage—from the early development of the bowstring to the multiple uses of textiles in industry,—we have made efficient use of the combined properties of lightness, permeability, flexibility and strength. If the textile contents of the average home were to be instantly removed we would suffer total destruction of our housing. Electrical installation would practically disappear; our beds would be stripped to springs and frame; our books would disintegrate; our windows would cease to operate; carpets, hangings and shades would go; and upholstery, napery and clothing would vanish.

Technical considerations are of increasing moment. Fibers are so small in diameter that many hundred may be combined into yarn thus providing added flexibility in the final fabric. A solid block of wood will easily resist any atempt to bend it with the hand, while the same size bundle of twigs can readily be bent. The multiplicity of fibers involved in a yarn also makes for better strength properties because of the statistical evening-up of inequalities from point to point in a given fiber and from fiber to fiber.

These inequalities are of great importance. Under stress any material fails at its weakest point. Faults in structure, irregularities in arrangement of components

and presence of impurities are sources of weakness. The textile manufacturer has long known that thick and thin places, knots, and dirt are undesirable and has constantly worked for improvements in processing which would result in better cleaning, blending and less piecing-up of yarns. Modern textile research is showing that better blending of molecules in fibers is equally desirable; that chemical purity of components is important and that the bonding of the atoms, molecules, fibrils and cells in fibers cannot be neglected.

Importance of Secondary Valence Bonds

Selection of the proper atoms for synthesis into molecules and of proper molecules for combination into fibers is a fundamental and vital consideration for the maker of artificial filaments. The chemist has progressed rapidly and far along these lines, and the physicist is now realizing how important a contribution he can make in devising means to arrange these molecules properly. He is increasingly recognizing that long, slender molecules must be intelligently grouped and bound together efficiently with electrical energy. Just as tie-strings replaced folds and overlappings as a means of fastening garments and were, in turn, replaced by buttons and button-holes; so the latter are being replaced by the more efficient zipper. Chemically and physically the points of mutual attraction between molecules (the chemist calls them secondary valence bonds) are being increased in number and more closely spaced for greater efficiency.

A zipper cannot be closed (Fig. 2) until the two halves are brought substantially parallel with each other. In similar fashion, the molecules, fringed with secondary valence bonds, must be parallel and brought close together before the points of mutual attraction can function properly. When they do, then the fiber becomes strong in its resistance to slippage of molecules past each

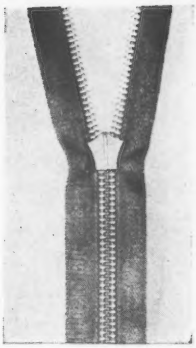

Fig. 2. A conventional type of Zipper—analogous to the combining of adjacent long-chain molecules by means of secondary valence bonds.

other. The structure of the fiber may be visualized therefore as held together by a large number of submicroscopic zippers. Then, as in wool, the longitudinal chains of molecules are fastened together with tie-strings (the chemist calls them cross-linkages or chains) made up of other long molecules. They are thus less rigidly held and can move back and forth by each other for relatively long distances without breaking these links. They form a lattice-like structure. Serious weakening of such fibers can be brought about chemically by rupturing these cross-linkages which then exert no restraining action on the slippage of molecules. The chemist can also substitute other atoms in these linkages which will modify the properties of the fiber. Thus Harris (1) and his coworkers have substituted atoms which make the resulting fiber indigestible to moth larvae and hence effectively mothproof the material.

Nature has succeeded in arranging molecules in groups of long chains which can be separated out by breaking up the fiber through slight swelling and pressure and which become visible under the miscroscope (particularly in polarized light, see TEXTILE RESEARCH, Dec., 1942, p. 23) as what we term "fibrils." Apparently these units run unbroken from one end of the cell to the other and are the principal constituents of the cell wall. Artificial fibers do not have a cell structure, nor break down into fibrils. These structural units seem unique in natural fibers as the result of growth processes,—as the product of a living organism.

Perhaps the nearest approach to such a structure is

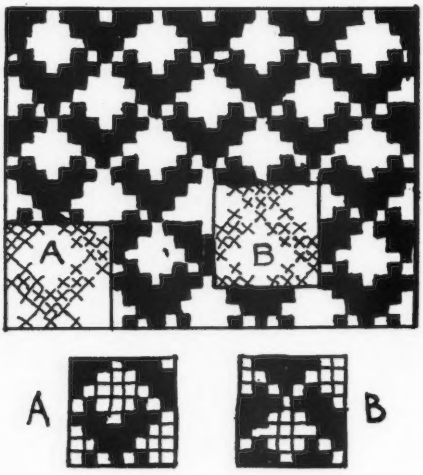

Fig. 3. Repeats of a weave design may start anywhere—but are all of the same size. In this example the 8 x 8 squares at 'A' and 'B' are each repeats of the weave.

the formation of crystals of non-living or inorganic substance. Here we have a definite crystal pattern, characteristic of the substance and resulting from a "growth" or process of orderly accretion. In a sense, then, the ordered structure of the fibril may be termed crystalline or crystal-like and each repeating pattern (like a weave repeat in a fabric) (Fig. 3), along molecular chains may be termed crystallites. The crystallite (Fig. 4), is not a discrete structural entity which may be removed physically from the fiber; but is rather a geometric unit having a certain atomic symmetry and spacing. Its dimensions may be determined from X-ray diffraction data, as the dimensions of a grid-work may be determined from a diffraction pattern formed by the interference of ordinary light waves. As in a weave repeat, the measurements may start at any point and proceed to the next repeating interval. It has the same convenience in the study of fiber structure and properties as has a state in the map and function of the United States. For purposes of organization and simplification, boundaries of each state are precisely located; but they are arbitrarily determined by political or other considerations, and do not exist naturally. Massachusets, Kansas and California are man-made geometric subdivisions of a part of a con-

tinent. They are bounded and vary as expediency or the location of rivers, mountains or valleys may dictate. Thus a crystallite in cotton includes portions of five different adjacent molecular chains and changes its size and shape if the cotton is mercerized. When the cotton is broken up chemically for manufacture into rayon, the molecular chains are separated and broken up and the crystallites of cotton disappear.

The important thing is that crystallites may be noted in rayon filaments—particularly if they are of the "high tenacity" type where the molecular chains, at least in spots, are reasonably well oriented parallel with each other. This is an arrangement brought about by the treatment of the fiber physically and brings crystal-like regions into being once more. Where the arrangement is not so perfect we have amorphous regions. The location, magnitude and formation of these "crystalline" and "amorphous" regions greatly affect the physical and chemical properties of the fiber. They alter the creep and creep recovery properties as has been demonstrated by Leaderman (2) in his researches at M.I.T. for the Textile Foundation. Crudely, the behavior of such a composite system is similar to that of a complex arrangement of springs and dashpots so far as the load stretch relationships are concerned.

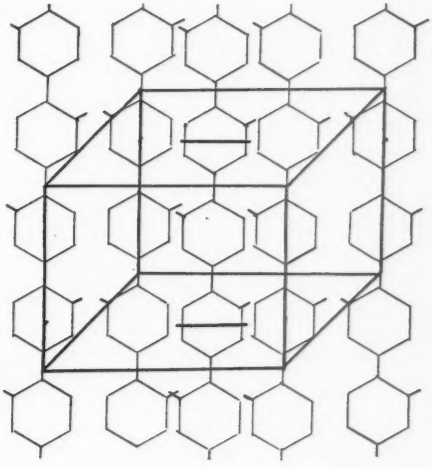

Fig. 4. Diagram of a crystallite of cellulose. Note that it includes portions of five molecular chains, and is a repeating unit of structure.

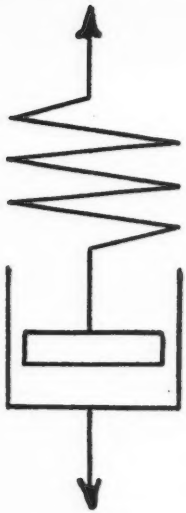

Fig. 5. Diagram of a Maxwell Unit.

A combination of a spring and dashpot (Fig. 5), in series which Leaderman calls a "Maxwell unit" may be identified with the secondary valence bond between the chains of molecules in the amorphous regions (where the chains are less well "lined up" or "oriented"). A spring alone, may be identified with the primary valence bonds holding the molecules together in chain form—also in the amorphous regions. Thus this portion of the structure may be represented by a model composed of a number of units of varying spring and dashpot characteristics in proper arrangement with each other and another single spring. If the characteristics of the Maxwell units are worked out in a proper distribution mathematically, the entire model may give interesting information as to the behavior of at least some textile fibers.

Fairly simple investigations of the extension and recovery properties of textile fibers as a function of time, therefore, throw much light on the ultimate chemical architecture of fibers. Such investigations demonstrate forcefully that no definite boundary exists between physics and chemistry. The latter is principally concerned with the kinds and amounts of chemical compounds, molecules and atoms; while the former has dealt more particularly with the results of the actions of various forces on the resulting materials. Now it is realized that both have common ground in the matter of the arrangement of the atoms and molecules which, together with their nature and amount, determine the resultant properties of the final materials. The architecture of fibers is being studied by the organic, physical

and colloid chemist and by the physicist, biologist and botanist by means of polarized light, ultra-violet light, infra-red radiation, X-ray diffraction, micro-manipulation, and electron microscope techniques. No one method can give more than a partial picture of the inter-relationship of atom, molecule, crystallite, fibril and cell in the fiber; but together they present an ever clearer picture of the real "inside story" of fiber structure.

The microscope carries us down to magnitudes of less than one micron (.001 mm.) with visible light. The electron microscope works with the tiny fragments of cell or fiber of only a few times this dimension in size and gets down another decimal place or two in order of magnitude. X-ray diffraction researches work in the range of a few ten-thousandths of a micron and show something of the placement of atoms in the molecule as well as of the arrangement of molecules themselves. Improvements in the use of electron beams of longer wave length than X-rays but of shorter wave length than those employed by existing electron microscopes may eventually bridge the gap between the information existing as to the constitution of the molecule and that of the constitution of the cell wall or the synthetic filament.

The modern scientist is beginning to picture structures of the sort once described by chemical formulae as three-dimensional units and to think of them more in terms of an architect's blueprint than as a sheet of builder's specifications. This way lies progress. Intelligent textile technologists must soon grasp the significance of this sort of visualization and use it for the better engineering of textiles for all purposes. Nature is still the master builder—and works in a mysterious way her wonders to perform. Modern science is contributing the wider vision needed to dispel the mystery.

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1. Geiger, Kobayashi, and Harris. The Chemically Modified Wool —Textile Research, Vol. XIII, No. 1, Nov. 1942, p. 21.
2. H. Leaderman. Elastic and Creep Properties of Filamentous Materials and Other High Polymers—(In press).

RESEARCH ACTIVITIES

"Among the most important research projects having to do with the future use of cotton is the development of control of the drape characteristics of cotton fabrics. It looks to the day when cotton can be made to drape like silk, or can be stiffened to the crispness of starched linen. I believe I am safe in saying that if this development, which has already made much progress, can be successfully completed, it will make the most revolutionary contribution to cotton's position in the apparel market that has been made since Ely Whitney invented the cotton gin." This statement was made in a recent issue of the Journal of Commerce by Oscar Johnson, president of the National Cotton Council.

WPB has ordered the sale and purchase of all organic dyestuffs and organic pigments for civilian use cut an average of 40 per cent below 1941 figures.

F. S. Blanchard addressed the Research Group of the National Cotton Council at its recent meeting held at Memphis, Tenn. Mr. Blanchard discussed some of the more important research problems in which the Southern mills are interested and described some of the research projects in which the Textile Research Institute and Textile Foundation are now engaged.

At the February meeting of the American Association of Textile Technologists held at the Builders Club, 2 Park Avenue, New York, Col. Max R. Wainer, Director, Quartermaster Board, Camp Lee, Va., described the practical field testing of textiles at Camp Lee.

Alien Property Custodian Makes Available To American Industry All

Patents of Foreign Nationals

INVENTIONS representing some of the finest foreign research achievements in modern science, and patents covering processes which have given the Axis nations the ability to carry on mechanized warfare for years while cut off from sufficient supplies of basic raw materials, from petroleum, rubber, certain non-ferrous and alloy metals, sugar, cotton and wool, are included in the list of patents seized by the Alien Property Custodian.

Title to every live patent and patent application owned by a national of an enemy or an enemy-occupied country is now vested in the United States Government, except for certain cases requiring further investigation. There already stand in the name of the Alien Property Custodian well over 25,000 patents formerly owned by enemy nationals and about 15,000 patents of nationals of enemy-occupied countries. In addition, this office holds 5,500 patent applications representing the newest processes and discoveries. The latter, in particular, which represent the latest research kept secret until now, have great economic value. For example: the electrical ignition systems of Robert Bosch; the automobile motor inventions of Daimler-Benz, Fiat, Marelli; the chemical products of Montecatini, Kuhlmann, Norsk-Hydro; the armaments of Schneider et Cie, and Skoda; the alloys and metallurgical equipment of Societe General Metallurgique de Hoboken; and the electrical equipment of Kwaisha Toden Benku Kabushiki.

There are many opportunities here for the small manufacturer to obtain the use of processes which will

help him convert his plant to war production, and to establish a sound business in the postwar world. Every manufacturer applying for a license under any enemy or enemy-controlled patent which is essential for war production can be assured that he will be licensed within a few days.

Where exclusive licenses are not already outstanding to American industry, licenses will be issued to any reputable American firm or individual. These licenses will be non-exclusive and non-assignable, they will be for the duration of the life of the patent, and the licenses will be royalty free except that in the case of patents and applications standing in the name of nationals of ENEMY-OCCUPIED countries, reasonable royalties may be charged at the end of the war-emergency period.

When an American holds an exclusive license under a vested patent or patent application formerly owned by a national of an enemy-occupied country, the license and existing royalty arrangements will usually be allowed to stand and, subject to the over-riding consideration that nothing can be permitted to hinder the war effort, the licensing policy will not disturb *bona fide* American interests in vested enemy and non-enemy patents and patent applications.

Textile manufacturers will find listed many patents under important classifications such as: Bleaching, dyeing, fluid treatment, and chemical modification of textiles and fibers; laminated fabric and analogous manufactures; fiber preparation; cloth finishing; spinning and weaving.

An "Index" giving a classified list of patents, with the number of patents under each classification, also a booklet entitled "Patents At Work," describing the plan and how to obtain licenses are ready for distribution. These lists will reveal many valuable processes which can be effectively used in this country. All inquiries should be sent to: *Office of Alien Property Custodian,* Chicago, Illinois.

RESEARCH BRIEFS

Production of Coated Fabrics

PRODUCTION OF COATED FABRICS. John B. Cleveland. *Textile World, 92,* 76–7 (Dec., 1942).

Vinyl resins are almost entirely replacing rubber for chemical proof and waterproof coatings of textiles. Properly plasticized, the polyvinyl resins exhibit an elasticity and resistance to hot and cold temperatures that rival rubber and their weathering properties are superior. The resin is applied to the fabric on a spreader and the coated fabric is subsequently dried and calendered in much the same manner as when rubber is used. The coated fabric is used for lightweight airplane camouflage paulins and type HH cotton balloon cloth.

Synthetic Plastics in Textiles

SYNTHETIC PLASTICS AND THE TEXTILE INDUSTRY. P. B. Sarkar. *Textile Colorist, 64,* 530–3 (Nov., 1942). Through *Indian Tex. J.*

Synthetic plastics have replaced some wooden and metallic parts on such textile machines as tenter frames, roving machines, rayon spinning pots, and reels. They are used to produce coated fabrics. The most recent development is the impregnation of fabrics to produce various effects without changing their normal appearance. By this method it is possible to impart to rayon the resilience of wool, to cotton the luster of silk and stability of worsted, and to rayon or cotton the coolness and absorbency of linen. One of the most important developments is that of anticrease finishing for cotton fabrics. Resins, cellulose derivatives, and quaternary ammonium compounds are being used in increasing amounts for the attainment of permanent finishes which is not possible with the gums, oils, waxes and starches. The affinity of many fibers for dyes can be increased by treatment with a

cyanamide-formaldehyde condensate and the fastness of the dyes is enhanced. Applications in sizing and printing are also discussed.

Microscopy of Textile Fibers

MICROSCOPY OF TEXTILE FIBERS AND THEIR IDENTIFICATION. W. Krauss. *Rayon Textile Monthly, 23,* No. 10, p. 51, 599–602 (Oct. 1942).

The basic problems of fiber microscopy are discussed under four headings: (1) the identification of fibers found in various textile products, (2) the quantitative analysis of fibers found in mixtures, (3) the determination of the quality of fibers and (4) the identification of fiber damage incurred during processing, storage, or while in the possession of the customer. Photomicrographs are used to illustrate various topics discussed in the text.

A Cotton Slasher Blanket

A COTTON SLASHER BLANKET. G. H. Dunlap. *Textile Research, 13,* 4–8 (Nov., 1942).

A cotton slasher blanket has been developed which, though not having the cushioning properties of wool, has the advantages of low cost and long life. Data on mill tests are given.

Vinylidene Chloride Fabrics

VINYLIDENE CHLORIDE YARNS NOW WOVEN INTO GOODS. H. R. Mauersberger. *Rayon Textile Monthly, 23,* p. 69, 615–16 (Oct. 1942).

The new vinylidene chloride fabrics are handled and processed on standard textile equipment. They are characterized by unusual strength, extreme fatigue resistance and general durability. They are fireproof, waterproof, weatherproof, acid or alkali resistant, easy to clean, lustrous or opaque and of natural yellow or in

a riot of color of great inherent fastness. Additional chemical and physical properties and uses are given. Examples of such fabrics are shown. Only coarse monofilament yarns have yet been prepared, but experiments are in progress on the production of fine multifilament yarns.

Cuban Textile Fibers

REVIEW OF THE CUBAN TEXTILE FIBER SITUATION. M. L. Blanco. *Rayon Textile Monthly, 23,* 596–7 (Oct., 1942).

Research and development on a number of the fiber-bearing plants that grow abundantly in Cuba, such as Guasimilla, Guama, Canajaguilla, Sanseviera, Ramie, Malva Blanca, Luffa, and Hennequin are outlined.

Brazilian Fibers for Rope and Cordage

FIBERS OF BRAZIL. C. E. Nabuco de Araugo. *Jr., Ind. Eng. Chem., News Ed., 20,* p. 1296–9 (Oct. 25, 1942).

A discussion of both indigenous and exotic fiber plants of Brazil, especially of those fibers used in the manufacture of bags, rope, cord, string, hawser, etc. Methods of production are described briefly and the properties of the fibers are summarized in a table.

Rayon vs Cotton Cord for Tires

ARMY PROVES RAYON CORD SUPERIORITY OVER COTTON FOR TIRES. Anon. *Rayon Textile Monthly, 23,* p. 37, 641 (Nov. 1942).

Excerpts from reports of tests by tire manufacturers and Army are given. Although tests indicate superiority of rayon over cotton cords used at present, newly developed low gauge cotton cord is adequate for Army tires of 7.50–20 and smaller. Insufficient data exist as to its performance in the larger sized tires.

Tests Prove That Increased Twist Rapidly Lowers the

Strength of Cotton Fiber Bundles

There appeared in the December 1942 issue of TEXTILE RESEARCH *an article entitled "Plastic Bonded Cotton Fiber" by M .A. Goldman and Gerner A. Olsen, that has attracted some attention. In this article the authors describe a new process for laying a thin web of cotton fibers in parallel arrangement and bonding them to form unwoven sheets. Early experiments have indicated that this method may utilize the inherent high tensile strength of the cotton fiber, which strength is, to a great extent, lost when the fibers are twisted to form a yarn. It is well known that the tensile strength developed by cotton yarn is only from 10 to 20 per cent of the combined strengths of the fibers in a given cross section of the yarn.*

*A statement in the article that a part of the loss in strength is due to the fact that the full strength of a tensile member is only attained when it is perfectly straight, with the applied load acting along its longitudinal axis, is confirmed by data given in the following letter received by Mr. Goldman from R. W. Webb:**

"I have noted with interest the article by you and Mr. Olsen entitled 'Greater Tensile Strength for Plastics is Indicated by Experiments With Unwoven Plastic Bonded Cotton Fibers' which has appeared in the December issue of the journal TEXTILE RESEARCH.

In your article, you mention the fact that Matthews has

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Fig. 2. Pressley Strength Tester for determining the bundle strength of cotton fibers.

reported a strength of 53,400 lbs. per sq. in. as the tensile strength for cotton fibers, and that this is not far below the A.S.T.M. specification of 60,000 lbs. per sq. in. minimum for structural steel. You also say that in considering strengths of materials, the theoretical allowable stresses of cotton dwell within the range of some of our most useful metals; and that, should these theoretical considerations prove to be correct and if it is possible in practice to approach them, the applications of such a material should be many.

In this connection, I have thought that you and Mr. Olsen might like to know of some of the findings pertaining to fiber strength which we have obtained for cotton. We have made fiber strength and other related fiber tests on thousands of samples of cotton over a period of years, many of the samples of which represent known varieties and known growth conditions. The method of testing that we have used for determining fiber strength, expressed directly in terms of lbs. per sq. in. is the Chandler, round-wrapped-bundle method which was developed

in our laboratories some years ago and which has been described more recently in the A.S.T.M. handbook for the testing of textile materials. We also are using now the Pressley, flat-unwrapped-bundle method for determining the strength of cotton fibers which permits the fiber strength being expressed as an index and which, by means of a conversion formula, we can translate into terms of lbs. per sq. in. on a basis of the results obtained by the Chandler method. The Pressley method has been described in a recent issue of the A.S.T.M. bulletin.

In the light of our large volume of data, we feel that the value of 53,400 lbs. per sq. in., which Matthews has reported for the strength of cotton fibers and which you are using in your calculations and thinking, is extremely low for cotton in the accepted sense; i.e. cotton which has not been allowed to deteriorate or be damaged by the action of light, weather, microorganisms, chemicals, or other agencies. On a basis of a large number and wide range of American upland cottons, the type of cotton that makes up the bulk of the American cotton crop, we have obtained an average strength value around 80,000 lbs. per sq. in. some cottons of this type have been observed to test as high as 106,000 lbs. per sq. in.

As regards American Egyptian cotton, we have found fibers of this growth to give average strength values between 85,000 and 90,000 lbs. per sq. in. some individual cottons of this type, however, have given somewhat higher strengths.

Sea Island cotton has given us the highest fiber strength of any cottons tested to date. Our findings show that, on the average, the fiber strength of this growth ranges from 95,000 to 110,000 lbs. per sq. in. We have found some individual Sea Island cottons whose fibers possessed the enormous strength of 120,000 lbs. per sq. in.

In your article, you further state that the full strengths of a tensile member is attainable only when it is perfectly straight, with the applied load acting along its longitudinal axis; and that, in many cases of plastic re-enforce-

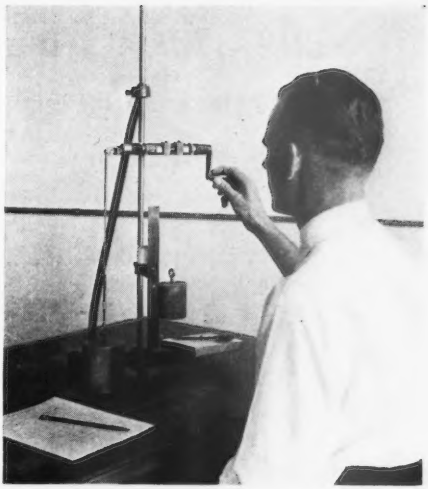

Fig. 1. Wrapping Device for preparing bundles of cotton fibers for testing by Chandler Strength Method.

ment, little or no thought has been given to this very important fact.

In this connection, I have thought that you and Mr. Olsen might be interested in some strength values which we obtained some time ago with cotton fiber bundles possessing different amounts of twists and tested by the Chandler bundle method. In one experiment, we used Sea Island cotton which, when tested with fibers in a parallel state, gave a strength of 98,000 lbs. per sq. in. Fiber bundles were tested containing 1, 2, 3, and 4 turns per bundle, respectively, which calculates to be 1.60, 3.20, 5.33, and 8.00 twists per inch, respectively. The respective average fiber bundle strengths which we obtained were 93,500, 80,200, 65,900 and 48,100 lbs. per sq. in. as compared with 98,900 lbs. per sq. in. for the average of the 'control' fiber bundles containing no twists. The coefficient of correlation between fiber strength and twist of bundle, or the 'r' value, calculated to be — 0.99.

The figures cited above show well how rapidly cotton fiber bundle strength is lost with insertion of increasing twist and with departure of the fibers from a straightened condition. These findings also may be taken to suggest, we think, that the ultimate strength of cotton fibers would be even higher than the very high values cited above, if the fibers did not possess the highly spiralled and twisted condition which they do by nature."

RESEARCH AIDS

A Handbook of Substitutes*

Over a period of years, the author has developed substitutes or alternatives for numerous products in diverse industrial fields. To this file has been added the suggestions of others and references from scientific and technical journals and texts. Hence this book is a concentration of the experience of many chemists, engineers, and other technical workers.

"Substitutes" presents a tabulation of chemicals, metals, fibers and other commercial products with a list of alternatives whose properties are such as may qualify them as possible replacement products.

Included is a plan for choosing the proper substitute, with a discussion of the many factors to be considered in making suitable selection.

This book should prove of particular assistance to industry at this time since so many materials are rapidly becoming unobtainable.

* Substitutes—by H. Bennett, *Chemical Publishing Co., Inc.*, 234 King St., Brooklyn, N. Y. 225 pp. $4.00.

Tex Test Kit to Identify Fabrics*

Identification of fabrics has been complicated in recent years by the introduction of many new textiles and the use of fiber mixtures because of war restrictions.

A complete "pocket size" textile identification set, including a 56-page manual dealing with textile classifications and tests, has been made available by Fisher Scientific Co. The Tex Test Kit provides simple equipment for elementary physical and chemical tests. The new kit contains essential apparatus and solutions for study and identification of many different fabrics.

* *Tex Test Kit, Fisher Scientific Co., Pittsburgh, Penna. Also from Eimer & Amend, 633 Greenwich St., New York, N. Y. $5.00.*

Fig. 1. The new Tex Test Kit contains the solutions, apparatus and instructions necessary for the simple identification tests.

The contents of the manual, prepared by textile authorities at the Research Bureau for Retail Training, University of Pittsburgh, have been examined and approved by the Fellowship on Commodity Standards at the Mellon Institute for Industrial Research. It is a condensed text devoted to the procedures of testing, the listing of hundreds of different fabrics, definitions and a summary of man-made fibers.

Fig. 2. A drop of Texchrome applied to the fabric produces a different color for each of 12 different materials.

Research Reveals the Extent of the Combination of

Wool Protein With Weak Acids

By JACINTO STEINHARDT, CHARLES H. FUGITT, AND MILTON HARRIS*

Wool is often exposed during processing to solutions which contain weak acids. Certain of these acids have long been known to have profound effects on the swelling and the elastic properties of wool fibers. Nevertheless, practically all of the studies which have been made on the chemistry of the reaction of wool with acids have been made with strong acids, i.e., those which are totally dissociated into their constituent ions. The present paper (Combination of Wool Protein with Weak Acids), by research associates of the Textile Foundation at the National Bureau of Standards, fills in part this gap in our knowledge.

NUMEROUS STUDIES HAVE BEEN MADE of the combination of wool with acids and bases [1, 3, 5, 6].[1] With the notable exception of some measurements by Speakman and Stott [1], practically all of these studies have been made with strong acids and bases, which are totally dissociated into their constituent ions. Thus, little is known of the effect of the presence of undissociated acids on the equilibrium between wool and hydrogen ions, or of the relative affinities for wool of the anions of various weak acids. Such knowledge is of practical interest because wool is

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[1] Figures in brackets indicate the literature references at the end of this paper.

often exposed, in processing, to solutions which contain weak acids such as acetic, formic, or glycolic.

It is the purpose of the present paper to show the extent to which wool combines with a number of weak acids, and to demonstrate that wool combines not only with the ions of these acids but with molecules of the undissociated acid as well. The very large extent of combination with wool of such weak acids as formic acid and monochloroacetic acid, in the undissociated form, acquires particular significance in view of the long-known profound influence of these substances on the dyeing, swelling, and the stress-strain characteristics of wool fibers [1]. Similar combination with undissociated acid by dissolved proteins has recently been reported [7].

Experimental Procedure

Details of the purification of the wool, and determination of the acid combined, and of pH, have been described elsewhere [3, 4]. Except where otherwise noted, all reagents used were of c.p. grade, and were used without further purification, except for the removal of traces of strong acids present as impurities. Glycolic acid was treated with barium hydroxide to remove sulfuric acid. Hydrochloric acid was removed from solutions of dichloroacetic acid by silver oxide. The phenolic derivatives and nicotinic acid were recrystallized from hot water from one to four times.

With one exception, all of the experiments were made at 0° C.

Results and Discussion

The results obtained with most of the weak acids used are compared in Fig. 1 with those previously obtained with one strong acid, hydrochloric [3]. This graphical comparison brings out clearly the principal difference between the behavior of strong and weak acids with respect to wool. Over a wide range of low concentrations, many of the acids are combined by wool at a given pH to about the extent that it combines with hydrochloric acid. The presence of undissociated acid at these

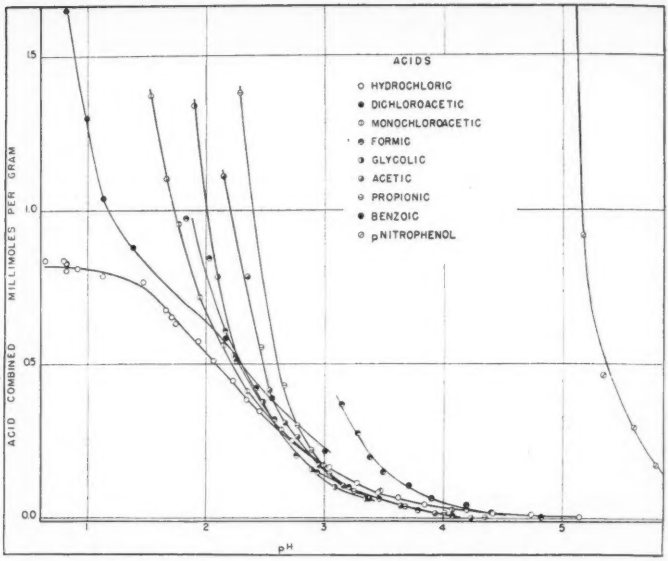

Fig. 1. The combination of purified wool with a number of weak acids at 0° C. The curve for hydrochloric acid is give for comparison.

concentrations is without appreciable effect. At higher concentrations, however, the amounts of weak acids which are combined increase more sharply than the amounts combined by hydrochloric acid, and, unlike the latter, give no indication of approaching a saturation value at about 0.8 millimole per g. Indeed, determinations have been made of amounts combined which are far beyond the upper limits of Fig. 1 (up to 4 millimoles/g).

It has been shown in earlier papers that different strong acids at the same concentration combine with wool to different extents [5, 6]. Most of the acids shown in Fig. 1 are organic acids of relatively low molecular weight, and would be expected, if totally dissociated, to give titration curves of wool similar to that obtained with hydrochloric acid [6]. If attention is confined to the lower portion of the curves obtained with acids of molecular weights below 80, it appears that this expectation

is well founded. Marked departures from the curve for hydrochloric acid appear only at concentrations at which the amounts of undissociated acid become greater than about 0.01 *M*.

It may be shown that the increased uptake of weak acids which appears at high concentrations is a rough measure of the amounts of *undissociated acid* which have combined with the wool, possibly by solvating it in competition with water. This demonstration depends on two experimental results which are described below: First, the amount of the "excess" uptake of any weak acid is approximately proportional to the concentration of undissociated acid. Second, the amount of excess uptake of any one acid at a given pH value is not fixed, but varies with the concentration of the weak acid.[2]

The first of these generalizations has been tested with the data for all of the carboxylic acids studied, with fairly satisfactory results. A representative set of calculations is reproduced in Table I. Monochloroacetic acid has been chosen as an example because the lower part of the curve of this acid coincides most closely with that for hydrochloric acid. Since this coincidence implies that the two acids, when dissociated, have closely similar affinities for wool, this acid should be most suitable for application of the test. As the table shows, over more than a fifty-fold range of concentration of acid, the proportionality between the extra uptake and the concentration of acid varies by less than half of its mean value, a satisfactory result in view of the assumptions underlying the calculations. The factor of proportionality, which hereafter will be referred to as the partition coefficient, shows a pronounced tendency to fall as the amounts combined increase. This must be expected, whatever mechanism of combination is postulated, since the amounts combined must approach an upper limit unless the fibers swell in-

[2] The concentration of weak acid may be varied, while the pH is held constant, by adding a strong base in such proportion that the ratio $\frac{\text{dissociated acid}}{\text{undissociated acid}}$ remains unchanged.

definitely and dissolve. The upper limit indicated by the results, however, must lie far above the highest experimental values shown in the tables. Thus, little purpose would be served by attempting to evaluate it by ex-

TABLE I. Combination of undissociated monochloroacetic acid with wool at 0° C.

pH	Acid combined[a]	HCl combined at same pH	Difference	Total acid present	Undissociated acid[b]	Excess combination divided by concn. of undissociated acid
	mmoles/g	mmoles/g	mmoles/g	mmoles/liter	mmoles/liter	
1.36	2.08	0.79	1.29	0.971	0.937	1.4
1.53	1.39	0.77	0.62	.477	.455	1.4
1.66	1.12	0.71	.41	.282	.265	1.5
1.76	0.97	0.66	.31	.184	.170	1.8
1.95	0.73	.59	.14	.0874	.0769	1.8
2.15	0.580	.504	.076	.0398	.0332	2.3
2.35	0.431	.403	.028	.0172	.0132	2.1

[a] No corrections have been applied for the error in calculating the uptake of acid which is introduced by the absorption of water by the fibers. See footnote 2.

[b] Values in this column are derived from the total acid present by utilizing Wright's value of the dissociation constant [8], and applying the law of mass-action. Since the proportion ionized is small, except in the more dilute solutions, little error is introduced by the neglect of activity-coefficients.

trapolation,[3] since the accuracy of the titration data is lower at high concentrations of acid, where only a small fraction combines, and the effects of water absorption by the fibers are greatest [3, 4].[4]

The values of the quotient (column 7 of Table I) at the highest dilution should come closest to expressing the

[3] The upper limit of the amounts combined may be fixed either by a stoichiometric limit, that is the replacement by acid of all the combined water; or by the development of a definite swelling pressure within an elastic structure, due to the difference between the molecular volumes of each acid and water. A decision between these alternatives requires accurate estimates of the maximum amounts of combination of different acids having widely different molecular volumes.

[4] Efforts have been made to estimate the latter effect by comparing the results of experiments with dry wool fibers and the results obtained with fibers containing 14 percent of moisture. These experiments indicate that the uptake of acid for the first three entries in Table I may be as much as 10, 6, and 3 percent higher than the values given. The quotients in the last column are correspondingly affected with a resulting improvement in constancy.

inherent tendency of the acid to combine with or to solvate wool. However, it must be recognized that it is these values which are most subject to error. They depend on the estimation of very small differences between the ordinates of the curves for monochloroacetic acid and for hydrochloric acid, and are also affected most strongly by any failure of the assumption that the anions of these two acids have the same affinity for wool.

Similar sets of calculations have been made for all of the acids represented in Fig. 1, with very similar results.

The second generalization results from experiments made with monochloroacetic acid over the same range of pH values but at higher concentrations of undissociated acid. This was accomplished by having present a constant amount (0.2 *M*) of potassium monochloroacetate in all the solutions. The results of these experiments are shown in Table II. Here the data for hydrochloric acid

TABLE II. Combination of undissociated monochloroacetic acid with wool, in the presence of 0.2 *M* potassium monochloroacetate at 0° C.

pH	Acid combined[a]	HCl combined at same pH	Difference	Total acid present	Undissociated acid[b]	Partition quotient
	mmoles/g	mmoles/g	mmoles/g	mmoles/g		
1.59	3.29	0.79	2.50	2.46	2.43	1.0
1.76	2.67	.78	1.89	1.73	1.71	1.1
1.93	2.31	.77	1.54	1.21	1.20	1.3
2.07	2.04	.75	1.29	0.885	0.876	1.5
2.23	1.66	.74	0.92	.594	.588	1.6
2.53	1.17	.70	.47	.299	.296	1.6
2.86	0.90	.62	.28	.143	.142	2.0
3.20	0.72	.55	.17	.067	.067	2.5

[a] See footnote *a* in table I.

[b] Values in this column are calculated by subtracting the anti-logarithm of the pH from the value in the preceding column.

which are subtracted are not the same as those used in Table I. Instead, values previously reported for the combination of hydrochloric acid in the presence of 0.2 *M* potassium chloride have been used. Again, the quotients entered in column 7 of Table II are not constant, but show

a trend. They agree fairly closely with the values of the quotients shown in the first table for similar concentrations of acid, but the spread is larger because higher concentrations of acid were used.[5] In keeping with the higher concentrations, very much larger amounts of acid are here combined, in the same range of pH which was covered in the experiment without potassium chloride. Thus, the amounts of monochloroacetic acid taken up in excess of the amounts of hydrochloric acid taken up at the same pH values have been shown in two different kinds of experiments to be proportional to the amounts of undissociated acid. It thus appears very likely that the excess uptake of acid is in the undissociated form.

The experiments just described show clearly that in evaluating the relative tendency of the weak acids represented in Fig. 1 to combine with wool, little consideration should be given to the pH range at which combination occurs. Thus, it appears from the figure that acetic acid is taken up at lower acidities than chloroacetic acid. This appearance depends entirely upon the fact that acetic acid is much the weaker of the two acids, and does not signify, as it would have in the work with strong acids that acetate has a higher affinity than monochloroacetate. Since the acid taken up is largely in the undissociated form, it is the concentration of acid rather than the hydrogen ion present which is significant. At equal concentrations of these two acid, considerably more of monochloroacetic acid is taken up than of acetic acid. It seems reasonable to interpret this combination with *undissociated acids* as a solvation, which depends on the fact that the acids are hydroxylic compounds as in swelling by water and the alcohols rather than on their nature as acids.

The inherent tendencies of the acids examined to combine with wool in their undissociated form have been calculated by the method shown in Table I. To avoid

[5] Corrections for the effects of water absorption by the fibers in this experiment would be higher than in the preceding experiment and would serve to reduce the spread.

inconsistencies which might arise from trends in the quotients, the values corresponding to the same extent of combination, 0.2 to 0.3 millimole of undissociated acid per g of wool, have been tabulated. The results are summarized in Table III. Approximate values for a few

TABLE III. Relative affinities of undissociated acids for wool protein at 0° C.

Acid	Partition quotient
Propionic	0.3
Acetic	0.4
Glycolic	0.6
Formic	0.7
Nicotinic	1.5[a]
Monochloroacetic	1.8
Dichloroacetic	2[b]
Benzoic	11
p-Nitrophenol	20
2,4-Dinitrophenol	50
2,6-Dinitrophenol	60
2,6-Dichloro-4-nitrophenol	100
2,4,6-Trichlorophenol	100

[a] The low value for nicotinic acid is probably due to the use of an incorrect value for the concentration of undissociated acid. It appears probable that a large proportion of the acid is present in the zwitterionic form.

[b] Owing to the high degree of ionization of this acid, the value given is highly approximate.

cyclic compounds not represented in Fig. 1 are also included. The range of the affinities of the undissociated acid for wool, as shown in the table, is approximately 300 to 1.

Estimates are available of the heats of combination of a number of strong acids with wool [4, 6]. Values between 2,000 and 12,000 calories have been obtained, the higher values being characteristic of the acids of high affinity. An effort has been made to obtain similar heat data for the combination of monochloroacetic acid *in the undissociated form.* This acid has again been selected, partly for the reasons already given, and partly because Speakman and Stott have determined by a calorimetric method [2] the heat liberated in its combination with wool. In the present study, an estimate of the heat of

combination has been made by comparing the partition coefficient at two different temperatures, 0° and 25° C.

Experiments with monochloroacetic acid at 25° C yield partition coefficients which were (within the experimental error) practically the same as those given in Table I. If it is assumed that a difference of as much as ten percent in the partition coefficient would have been detected, it follows from the Van't Hoff equation that the heat absorbed in the combination of the undissociated acid by wool is at most only three or four hundred calories per mole of acid [4]. This value is so close to zero that it supports the view that the combination with undissociated acid involves the replacement of another hydroxylic compound, presumably water, i.e., the mechanism is one of selective solvation. The heat of hydration of wool and other proteins is large, but the replacement of one solvated molecule by another which is held only slightly more strongly, would probably involve only very small heat changes, such as are found here.[6]

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[6] The heats of combination with wool of monochloroacetic acid, given by Speakman and Stott, are averages of the heats of both the ionic and the non-ionic reactions, and are therefore higher than those indicated here. It has already been pointed out [4] that the trends in the values given by these authors indicates a very low heat of reaction for amounts combined in excess of 0.8 millimole per g.

ABSTRACTS

Characterization of Cellulose

Hydrolysis and catalytic oxidation of cellulosic materials. R. F. Nickerson. *Ind. Eng. Chem.*, 1480–5 (Dec. 1942).

The quant. acid-hydrolysis method, reported previously (*Ind. Eng. Chem.* 13, 423–6 (1941)), is applied to various celluloses. The data seem to yield significant estimates of the cryst. and non-cryst. portions of the fiber, as well as a measure of the crystallite reactivity. The moisture affinities of intact celluloses and of their hydrolysis products offer considerable support for the idea advanced. Simultaneous utilization of quant. hydrolysis and moisture regain data confirms the theory of a structural heterogeneity and suggests that permeability of the crystallite is high in viscose rayon and mercerized cotton, while it is low or absent in natural celluloses. Other implications of the work are discussed.

Cellulose in Liquid SO_2

Reactions of cellulose in liquid sulphur dioxide. Philip C. Scherer, Jr., and Lawrence C. Brooks. *Rayon Textile Monthly* **23**, 718–20 (Dec. 1942); cf. *Ibid.* **23**, 657–8 (Nov. 1942).

Hydrolysis of cellulose to reducing sugars can be carried out by H_2SO_4 dissolved in liquid SO_2. The rate of reaction is very slow. The optimum times for the hydrolysis of cellulose to dextrins was detd. for wood, wood pulp, and viscose regenerated cellulose. A procedure for the isolation of cellulose dextrins from the acid reaction mixture was devised by which 97% of the theoretical yield could be obtained. The steps are as follows: (a) Hydrolysis of cellulose with conc. H_2SO_4 at 0° C. for 15 hr. for regenerated, 20 hr. for wood pulp, or 30 hr. for wood. (b) Extraction of excess acid by washing with liquid SO_2. (c) Neutralization of remaining acid by a soln. of Na_2SO_3 in liquid SO_2. (d) Extraction of the soluble dextrins from the sulfates and sulfites by liquid NH_3. (e) Evaporation of liquid NH_3 to give dry powdery dextrin product.

Cellulose Derivatives

Analysis of cellulose derivatives. Determination of free hydroxyl content. Carl J. Malm, Leo B. Genung, and Robert F. Williams, Jr. *Ind. Eng. Chem. Anal. Ed.* **14**, 935–42 (Dec. 1942).

A method for the determination of free or unsubstituted hydroxyl groups in cellulose derivatives has been developed, which makes use of the acetic anhydride in pyridine reagent of Verley and Bölsing. Acetylation at 75° to 80° C. for about 24 hours using 0.5-molar reagent in generous excess gave results on the samples of cellulose acetate, acetate propionate, and acetate butyrate tested, which agreed well with hydroxyl values calculated by difference from the acyl analyses. The effects of time, temperature, anhydride concentration, and excess were studied and optimum ranges for each were established. Equations and graphs are presented with which per cent hydroxyl can be converted to hydroxyls per glucose unit of cellulose. The method is useful for checking the accuracy of other analytical procedures, analyzing mul-

ticomponent derivatives whereby one component is calculated by difference, and correlating free hydroxyl with certain useful physical properties. Most commercial cellulose esters have essentially three replaceable hydroxyl groups per glucose unit of cellulose and this assumption is used in many calculations. Certain very low viscosity samples, however, contain more than three hydroxyls and the deviation from three may be used for the calculation of an average degree of polymerization of such samples.

Cellulose Ethers

Determination of alkoxyl groups in cellulose ethers. E. P. Samsel and J. A. McHard. *Ind. Eng. Chem. Anal. Ed.* **14**, 750–4 (Sept. 1942).

The Vieböck modification of the Zeisel method is applied to the detn. of methoxyl and ethoxyl groups in cellulose ethers. The HI should be very pure and from 56.5 to 57.0% and no solvents for the cellulose ether should be used. Improved apparatus is described and illustrated.

Dyeing of Cellulose

The rôle of salts in the dyeing of cellulose with substantive dyes. F. L. Usher and A. K. Wahbi. *J. Soc. Dyers and Colourists* **58**, No. 11, 221–8 (Nov. 1942).

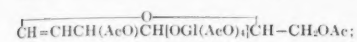
The influence of various electrolytes on the swelling of Cellophane has been studied by measuring the absorption of N-soln. of NaCl, KCl, KBr, KI, K_2SO_4, HCl and 25% aq. pyridine. The swelling in all of these, except HCl, is greater than in H_2O, but is not sufficient to account for the increased absorption of dyes in the presence of salts, except in special cases. Elec. effects due to salts have been investigated by measuring the distribution of ammonium and chloride ions between Cellophane (both dyed and undyed) and an external soln. of NH_4Cl; the dyes used were Sky Blue F^F, Chrysophenine G, and a basic substantive dye. A Donnan equil. exists in 0.1N, but not in 0.5N NH_4Cl soln.; in the former it becomes decreasingly important as the absorption of dye increases. Simplified expressions for the Donnan equil. that equate activity to conen. are not applicable, except approx. at low salt conen. and small dye absorptions. The action of salts in promoting the absorption of dye by cellulose cannot be correctly represented in terms of the Donnan equil. alone. Electrostatic effects due to the electrokinetic (ζ) potential of the cellulose play an important part in opposing the absorption of anionic dyes and in promoting that of cationic dyes, and such effects are progressively diminished by salts up to a conen., for the uni-univalent type, of 0.5N approx. The absorption of a dye tends to increase when its soly. in the dyebath is decreased, in whatever manner the decrease is effected. The depression of the soly. of a dye by salt is operative over the whole range of conen. up to that at which the dye is salted out or becomes markedly colloidal, and is the only important factor at conc. $> 0.5N$.

Synthesis of Cellobiose

Synthesis of cellobiose. W. T. Haskins, Raymond M. Hann and C. S. Hudson. *J. Am. Chem. Soc.* **64**, 1289 (June 1942).

Epicellobiose acetate was treated with Ac_2O and HBr to form acetobromoepicellobiose (*I*), yield 82%. *I* was treated with Zn dust in 90% AcOh containing, per 100 ml., one drop of 0.5% chloroplatinic acid in 50%

AcOH. *I* was thereby transformed into cellobial hexaacetate *II*,



yield, 69%. *II* was dissolved in EtOAc, and was agitated 20 hrs. at 25° C with 1.19 mol.-equiv. of 0.3545 *M* solution of perbenzoic acid in ether. Oxidation of substituted glycals with this reagent leads mainly to products in which the hydroxyl introduced at carbon atom two is *trans* to the substituent on carbon atom three (Levene and Tipson, *J. Biol. Chem.* 93, 631 (1931)). The product of oxidation was acetylated to yield a mixture of alpha- and beta-cellobiose octaacetates, which was deacetylated with $Ba(OMe)_2$ to yield cellobiose. 11 references.

Microchemistry

A review of organic microchemistry. L. T. Hallet. *Ind. Eng. Chem. Anal. Ed.* **14**, 956–93 (Dec. 1942).

A review with 378 references, 8 of which are specifically for pulp and textile fiber analyses, while some other methods described, such as for COOH, SH and Ac groups, will be of interest to textile chemists.

Continuous Peroxide Bleaching

Continuous peroxide bleaching as developed in the Piedmont Section. R. E. Rupp, et. al. *Am. Dyestuff Rptr.* **31**, 638–40 (Dec. 1942).

A continuous boiling and bleaching process is described that involves the use of a saturator, J-piler and washer for the boiling process and a similar unit for bleaching. The cloth may be processed in either rope or open-width form, but the latter is preferable. The essential feature of the process is the inclosed, heated, stainless steel J-piler, in which the goods, containing 2–3% of NaOH, remain for an hr. Many of the defects due to uneven circulation, filtration, and channeling, sometimes occurring in the kier-boiling process, are avoided. A 10,000 yd. lot of cloth can be prepd. for dyeing in 4 hrs. instead of 30–40 hrs. by customary processes. Strength, whiteness, fluidity, and absorbency values are given that compare favorably with data for kier-boiled goods. Steam and chemical consumption data are given.

Shrinkage and Stretch of Rayon Fabrics

Dimensional restorability of rayon fabrics. A. R. Waehter. *Rayon Textile Monthly* **23**, 659–60 (Nov. 1942).

An important factor in the serviceability of certain rayon garments is the extent to which they can be restored, without excessive stretching, to their original size and shape after laundering or wet cleaning. A test for this quality, called "dimensional restorability," has been devised by the U. S. Testing Co., and results indicate that it gives accurate predictions of actual garment performance. A 22-in. sq. of fabric is required for the test. A 10-in. sq. is marked off in an eccentric position inside the large sq., leaving tabs which indicate the warp and filling directions and through which tension is applied to the smaller sq. The sample is washed and dried, without stretching, on a flat-bed press, and then it is wetted and dried on the tension presser. Measurements are made on the small sq. The tension applied depends upon the amt. of shrinkage in the first washing, but in no case is more than 4 lb. recommended. Dimensional restorability of $\pm 2\%$ is considered satisfactory.

Algin for Filaments

Algin—its use in the textile industry and its possibilities of spinning into filaments. Anon. *Rayon Textile Monthly* **23**, 679–80 (Nov. 1942).

Some marine algae contain a voluminous material, called Algin, which hydrolyses to form one or more reducing acids possessing the properties of uronic acids. The phys. and chem. properties of Algin have made it an important finishing agent in the textile, paper, and leather industries and a raw material for the manuf. of synthetic yarns. Recent progress along this line is discussed and future plans for development are suggested.

Wearing Qualities of Silk and Nylon Hose

Wearing qualities of similar brands of silk and nylon hose compared. Genevieve M. Smith and Hazel M. Fletcher. *Rayon Textile Monthly* **23**, 75–6 (Nov. 1942); **23**, 62–4 (Dec. 1942).

Silk and nylon hose were given actual wear tests and also laboratory tests to compare the wearing qualities of similar brands. The nylon hose gave longer service than the silk. The average number of hours worn for the nylon was 448.59 and for the silk 156.74. By a statistical analysis of the data the nylon hose —controls and worn—were superior in bursting strength at the knee and in the leg than the silk. On the other hand, the bursting strengths of the heel, ankle, and welt of the silk and nylon controls were not significantly different. The toe of the unworn silk hose was stronger than that of the nylon. However, more holes were worn in the toes and heels of the silk hose than in the nylon. The majority of the failures in both the silk and nylon was due to snags that developed into runs. The nylon faded more than the silk. The greater fading of the nylon hose probably was due to the greater length of time worn and the number of times laundered. The silk hose were laundered an average of 12.2 times, the nylon 33.5 times. Under these conditions and using a 15-hour day as the basis, the silk hose cost $0.099 per day and the nylon $0.045. Although the initial cost of the nylon hose was greater they wore so much longer under these conditions that the cost was about one-half that of the silk hose.

Measuring Surface Areas

Specific surface measurements on compact bundles of parallel fibers. R. R. Sullivan. *J. Applied Phys.* **13**, No. 11, 725–30 (Nov. 1942).

The flow of air through compact bundles of parallel textile fibers has been studied in order to obtain values of the shape factor k_o for the channels through which the flow takes place. When the fibers are cylinders and the flow is parallel to their axes, k_o is an increasing function of the perosity ϵ. Tables and curves showing this relationship are given. For fibers such as cotton, where the shape and size of cross section changes along the fiber length, k_o changes less rapidly with ϵ. Data are given for this relationship.

Measuring Fiber Fineness

Measuring fiber fineness. M. A. Grimes. *Textile Research* **13**, 12–8 (Nov. 1942).

A new, rapid method of measuring fiber fineness consists in measuring the air permeability of weighed wads of cotton using the apparatus of Sul-

livan and Hertel and from this measurement, calcg. the surface per gram. Data obtained in this manner show a good correlation with weight-per-inch measurements made on the same cottons. Samples of 36 cottons, ranging from 2.69 to 5.87 mg. per inch, were studied. This method is rapid, the technique is simple, and the equipment is inexpensive. It is estd. that fiber fineness detns. can be made on 16–24 samples per day, allowing three measurements per sample. Only three to six weight-per-inch detns. can be made in the same period of time.

Measuring Surface Areas

A new method for measuring specific surfaces. James d'A. Clark. *The Paper Ind. and Paper World* **24**, 640–6 (Sept. 1942).

Taking advantage of the catalytic effect of a silver surface on the decomposition of H_2O_2, a method was devised for measuring the specific surface of paper pulp samples. The samples are coated with a thin layer of silver by treatment with Tollen's reagent, and are then treated with standard H_2O_2 for 50 secs. after which the reaction is stopped by the addition of H_2SO_4 and the H_2O_2 titrated with $KMnO_4$. Cellophane sheets of known area are used as a standard. Data for a number of paper pulps are given.

Glycerine

Glycerine in new textile developments. G. Leffingwell and M. A. Lesser. *Rayon Textile Monthly* **23**, 550–1 (Sept. 1942).

Glycerine is used in rayon warp-sizing as a softener and hygroscopic agent, in anti-mustard gas compositions, in screen printing to prevent the clogging of the metallic printing screens, as a stabilizing agent for titanium lakes of acid dyes, and as a constituent of the alkyd resins which are finding many textile uses. Other glycerine deriv. such as ester gums and ethers of polyglycerols are being used as textile finishing agents.

Chemistry of Starch

Some aspects of starch chemistry in relation to tubsizing. Ralph W. Kerr. *Paper Trade J.* **115**, No. 23, 292–6 (Dec. 3, 1942).

A review, with special reference to the existence of linear and branched molecules in starches, and their effects on adhesive and sizing properties.

Fractionation of Starch

Fractionation of Starch by selective precipitation with butanol. Thomas John Schoch. *J. Am. Chem. Soc.* **64**, 2957–61 (Dec. 1942).

By means of selective pptn. with butanol, a method of starch fractionation has been developed which avoids retrogradation and hydrolytic degradation. The pptd. fraction (constituting 22% of either corn or potato starch) is isolated in unique spherocrystalline form, probably as an addn. compd. with the butanol. The butanol pptd. fractions from corn and potato starches are more alk. labile than the respective raw starches, while the non-pptd. fractions are correspondingly more alk. stable, indicative of definite chem. differences. The butanol pptd. fraction from corn starch tends to revert to insol. form and appears to be the component of the starch responsible for gelatin and retrogradation. The non-pptd. fraction from corn starch constitutes the more sol. and stable component. With potato

starch, the phys. differences between the fractions are less pronounced, since the butanol pptd. portion is more sol. and less subject to retrogradation than the corresponding fraction from corn starch. The phosphorus in potato starch is principally assocd. with the non-pptd. fraction. Waxy maize starch is peculiar in possessing an unusually low alk. lability and in giving no ppt. with butanol.

Strength of Diastase Preparations

Quantitative strength determination of amylase (diastase) preparations. E. Lenk. *Soc. Dyers & Colourists* **58**, 138–41 (July 1942).

The optimum conditions for diastatic activity vary according to whether the enzyme is of animal, plant or bacterial origin. The apparent activity depends also on the starch variety used. The results obtained with various starches may be compared if a starch factor (Stf) is introduced. This factor is related to the monomolecular reaction rate constant (K) for the decompn. of starch in the following equation:

$$0.750\ K = Stf$$

$K = 1/t \ln a/a\text{-}x$; a = amt. in g. of starch; and x = amt. of maltose formed in time t. The activity of diastase prepns. is calcd. according to

$$af = Stf/g.\ diastase$$

The three stages of the enzymic decompn. of starch (a) liquefaction, (b) dextrinization, and (c) formation of maltose, are marked by changes in the color of the iodine-complex. Diastase prepns. of the same origin group are compared on the basis of the maltose formed up to the end of the dextrinization stage, marked by a color change from red to yellow. The amt. formed during this stage varies widely with the origin, so that comparison of prepns. of different origins can be made only on the basis of maltose formed during the liquefaction stage. With this in view, the following rapid method was devised: Two ml. of 1 percent starch soln. and 0.5 ml. of appropriate buffer soln. are placed in each of a series of test tubes held in a cold waterbath. Varying quantities of dil. diastase solns. are added. The tubes and contents are transferred to a waterbath at the optimum temp. for 16 min. The diastase-starch solns. are then poured into 40 ml. dil. I soln. (5 ml. 0.1 *N* I soln.) and, from the color produced, the amt. diastase needed to bring about the color change from blue to violet is detd. From this, the vol. in ml .of 1 percent starch soln. converted by 1 g. diastase can be readily calcd. This vol., the L_i value, is related to the activity as follows:

$$af_L = (Stf \times L_i)/100$$

Oxidation of Starch

Oxidation of raw starch granules by electrolysis in alkaline sodium chloride solution. F. F. Farley and R. M. Hixon. *Ind. Eng. Chem.* **34**, 677–81 (June 1942).

2 phases of the oxidn. of starch by halogens are investigated. One is a study of the mechanism of the oxidn. of starch paste by Br in neutral soln. Confirmatory evidence for the 4 expected types of oxidn. has been secured—namely, for the oxidn. of primary and secondary alc. groups, for the oxidative splitting of hexose units at a glycol grouping, and for the oxidn. of aldehydic and ketonic groups to non-uronic acid units. Information regarding the chem. mechanism of the Br oxidn. allows a bet-

ter interpretation of the sec. phase of the investigation which presents an electrolytic process for oxidg. raw starch granules by alk. NaOCl. The process is used to study the changes of raw starch during oxidn. and to det. the effect of various factors upon the course of oxidn. The changes during oxidn. were followed by detn. of hot viscosity, rigidity, gel strength, reducing power, turbidity, vol. of swollen granules, quant. birefringence, digestibility by beta-amylase, and microscopic observation of swollen granules by photomicrographs. The course of oxidn. was markedly affected by higher temp. and increased alky. An explanation of the action of alk. hypochlorite on raw starch granules is presented.

Starch Studies

Starch studies. Gelatinization of starches in water and in aqueous pyridine. J. W. Mullen, II, and E. Paesu. *Ind. Eng. Chem* **34**, 807–12 (July 1942).

Gelatinization of potato, tapioca, wheat, corn, and rice starch was studied in water-pyridine mixtures of concentrations ranging from pure water to pure pyridine. The gelatinization of these starches was followed by consistometric methods furnishing data relative to the temperatures, consistencies, and heats involved in the process. Correlation was established between these factors and the granule sizes of the different starch species. The disaggregation of the starch granules appears to reach a more advanced stage in a mixture containing 30% pyridine than in any other concentration. It was also found that the heat absorbed during gelatinization is more than ample to furnish energy for breaking one to two hydrogen bonds per glucose anhydride unit.

Starch Studies

Starch studies. Preparation and properties of starch triesters. J. W. Mullen, II, and E. Pascu. *Ind. Eng. Chem.* **34**, 1209–17 (Oct. 1942).

The various methods of prepg. starch esters have been treated from a crit. point of view, and a simple method of prepg. starch triesters in quant. yields by the use of the acid anhydride or acid chloride in pyridine is suggested. The properties of the acetates, propionates, and butyrates of 5 species of starch prepd. by this method are described. A complete investigation of the viscosities of the pyridine "solutions" of these esters has been made. It is shown that the properties of starch and starch esters, as they vary from species to species, may be correlated to a similar variation in mol. wt. The main difference between starch acetates of different species is one of mol. wt. due to varying amylose-amylopectin contents. From the viscosity studies it is concluded that the starch mol. forms a "clump" or a rough spheroid in three-dimensional space.

Animal Skin Proteins

Studies in animal skin proteins. VII. The acid-base binding capacity of limed skin. E. R. Theis and T. F. Jacoby. *J. Am. Leather Chem. Assn.* **37**, 611–20 (Dec. 1942).

The acid and base binding capacities were detd. on limed goat skin collagen and limed goat and calf hair at pH values ranging from 0.5 to 13.0. The binding capacities for the collagen was detd. for different periods of liming ranging from 1 to 15 days. Similar values were detd. for the hair after a 5 day liming period. Collagen and hair fix more acid and

more alk. after liming. The binding capacity of the collagen increases with time of liming. The isoelectric point of the collagen during liming shifted from pH 7 to pH 5.8 while that of the hair shifted from pH 5.7 to pH 5.9. Three reasons are given for the shift of the isoelectric point of the collagen (a) increase in activity of the carboxyl groups without production of new ones, (b) formation of additional acid groups, (c) the breakdown of acid amide groups into active carboxyl groups and NH_3. The increase in acid binding capacity may be due to addnl. basic group developed in the previous alk. hydrolysis or to a greater ease of hydrolysis also caused by the alk. treatment especially below pH 3.0. The change in the isoelectric point of the hair is attributed to the development of stronger basic groups or to the reaction of sulfhydryl groups formed by the reduction of the –S–S– type of linkage. The increase in acid and base binding capacity of the hair is explained by the formation of addnl. acids and basic groups by a similar reduction and further transformation of the cystine groups.

Felting of Wool

The effect of alkaline treatments on the felting properties of wool. Joseph W. Creely and George C. LeCompte. *Am. Dyestuff Rptr.* **31**, No. 26, 667–70, 682 (Dec. 21, 1942).

Results obtained on samples of a fine two ply wool yarn treated with aq. and alc. soln. of alkalies, a soln. of 1% H_2SO_4 and 0.02% of a com. wetting agent of the Igepon type, and various NH_2 deriv. are listed. The results indicate that alkalies which react with wool so as to affect principally the surface, reduce the rate of shrinkage of the treated wool; alkalies which act so as to affect the interior as well as the surface of the fibers increase the rate of shrinkage of the treated wool. Whether the alkalies attack the surface only, or both the surface and interior depends upon the kind and concn. of alkali, time of treatment, and temp. of bath.

Felting of Wool

Researches in wool felting. Part III. John Schofield. *J. Textile Inst.* **33**, No. 11, T181–94 (Nov. 1942).

There is a marked difference in the behavior of masses of wool fibers directly felted and cloth fabrics worked in a milling machine. In consequence thereof, the approach to the felting problem in these exp. consists in the use of masses of wool in the fiber or filament condition as distinct from cloth, etc., made from wool. The factors which effect felting, in their order of importance, are: movement of fibers, compressibility, lie or distribution of the fibers, length of fibers, temp., and fiber characteristics. These factors are described and explained in their relation to the interlacing theory of wool felting.

The following abstracts will be found in "Research Briefs."

Synthetic Plastics and the Textile Industry. (See page 15.)
A Cotton Slasher Blanket. (See page 16.)
Cuban Textile Fibers. (See page 17.)
Production of Coated Fabrics. (See page 15.)
Vinylidene Chloride Fabrics. (See page 16.)
Fibers of Brazil. (See page 17.)
Rayon vs Cotton Cord. (See page 17.)
Microscopy of Textile Fibers. (See page 16.)